A Dual-Polarized, Dual-Frequency, Corrugated Feed Horn for SMAP
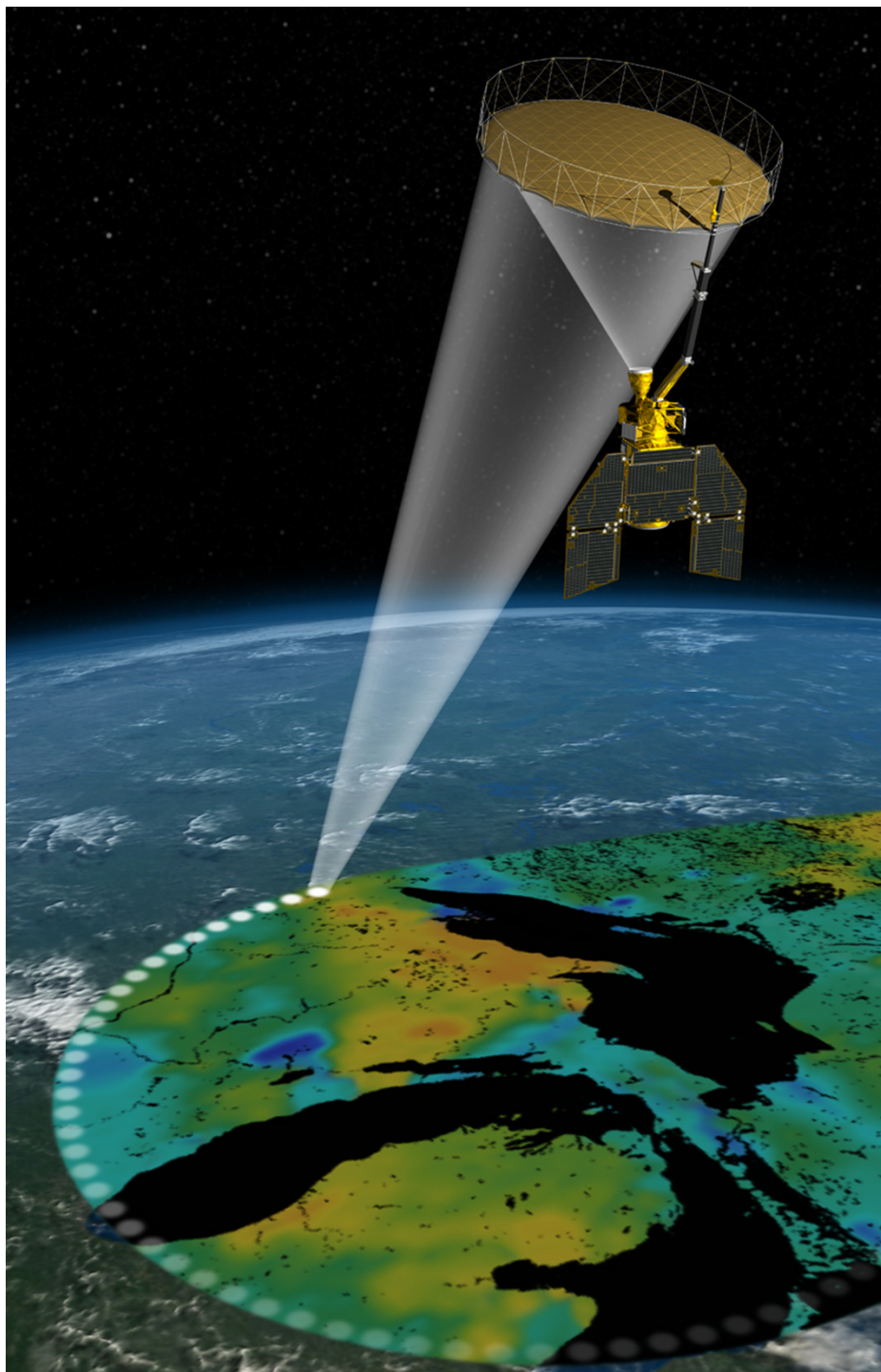
Paolo Focardi & Paula Brown
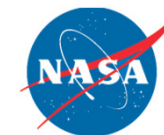*Jet Propulsion Laboratory, California Institute of Technology*

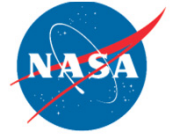*2012 IEEE International Symposium on Antennas and Propagation*

Chicago, IL
July 10th, 2011

Outline
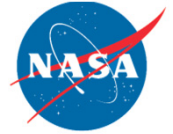
- Overview of the Soil Moisture Active and Passive (SMAP) Mission & Instrument

- Basic Layout of SMAP "E" Configuration

- Feed Horn Components

- Major Design Drivers & Requirements

- Thermal and Alignment Tolerances

- OMT Split Design

- SMAP Scale Model

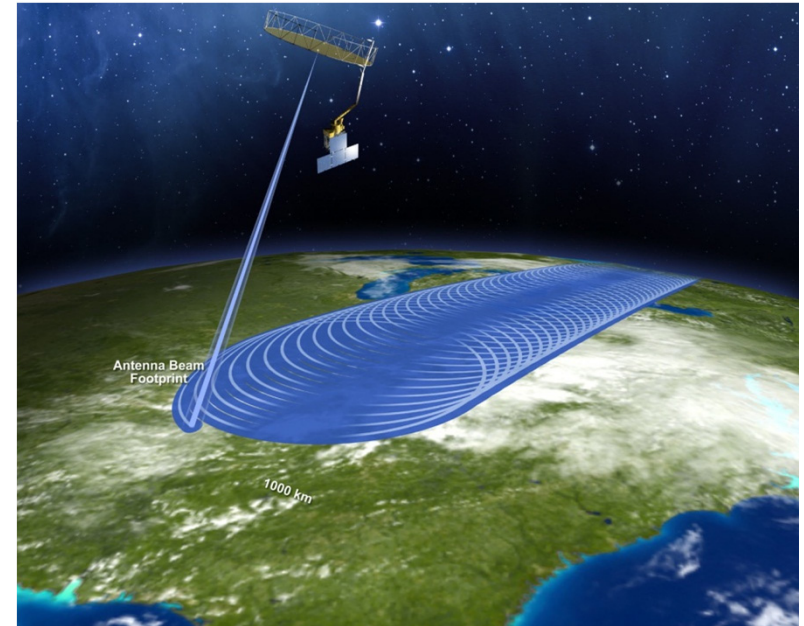- RL & Pattern Measurements

- Conclusions

Mission Overview

- NASA's Soil Moisture Active and Passive (SMAP) mission will measure Earth's soil moisture and its freeze/thaw state over a 3 year period

- Applications:
  - More accurate and longer-term weather and climate predictions
  - Earlier drought warnings
  - Improved flood and landslide predictions
  - Improved agricultural production predictions
  - Better understanding of the global carbon cycle

- Near-polar, sun-synchronous orbit of 680 km
- Planned launch date of November 2014
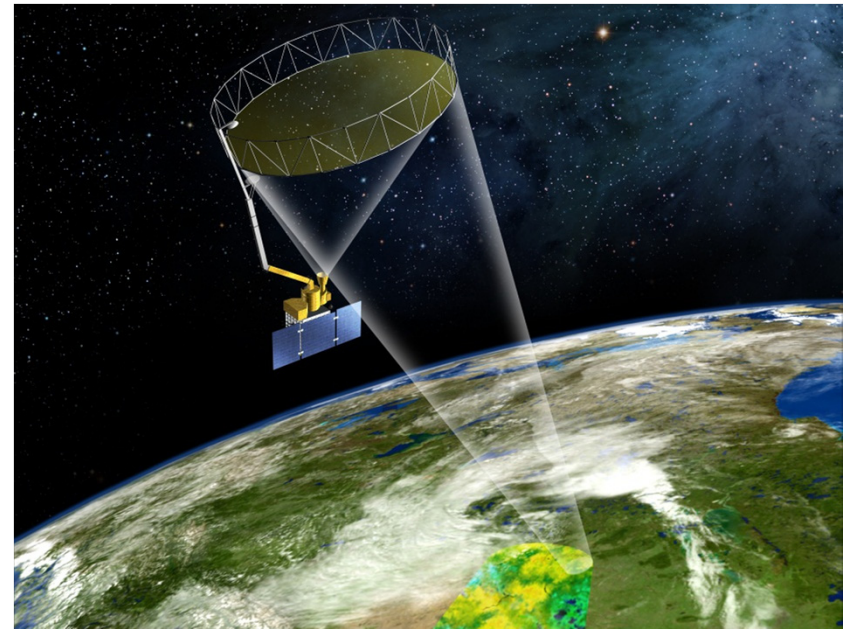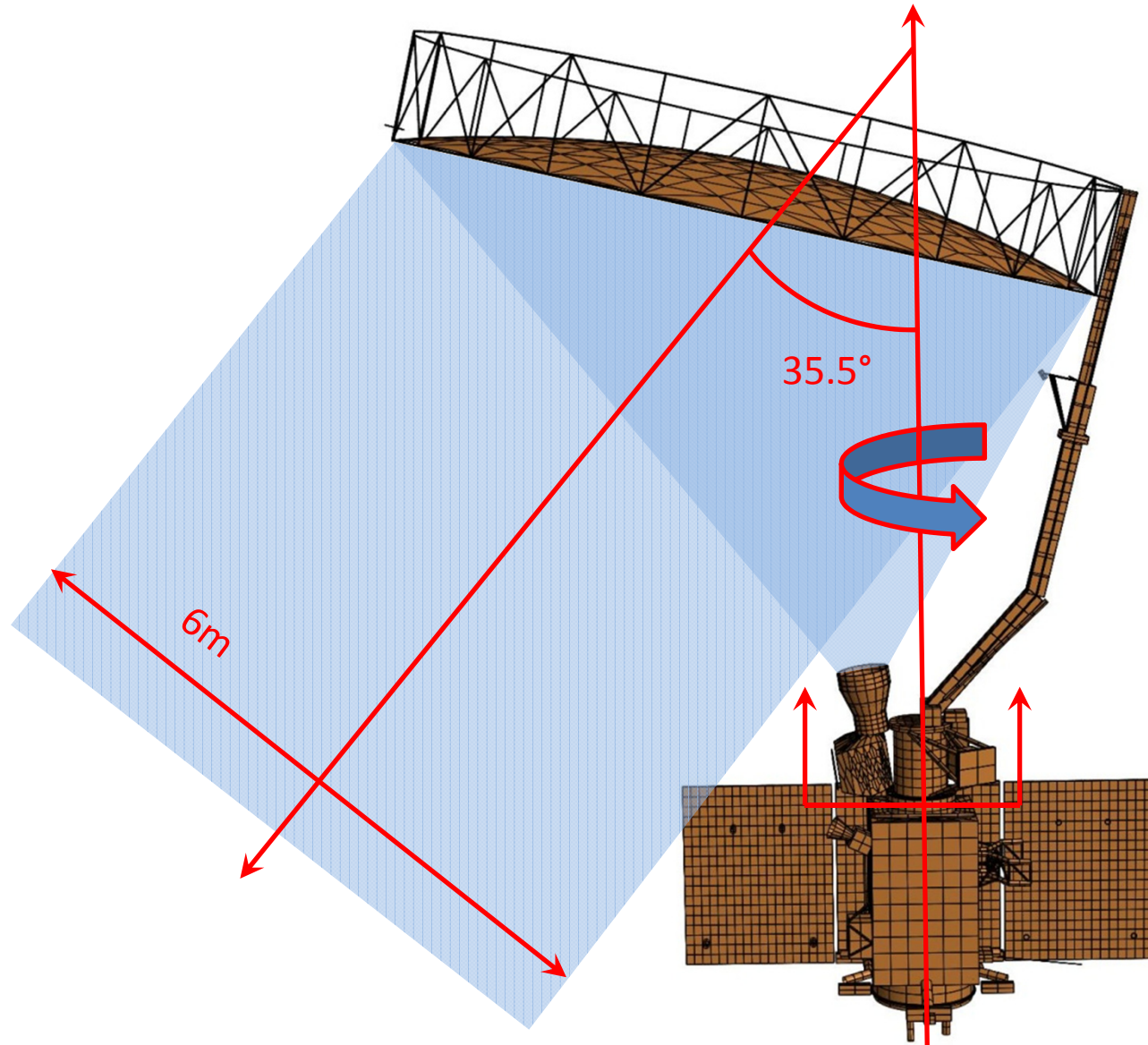
Instrument Overview

- An L-band Synthetic Aperture Radar (SAR) and L-band radiometer (RAD) share an offset 6-m deployable mesh reflector and feed

- The antenna boresight beam is pointed 35.5° off nadir

- The instrument spins at approximately 14.6 RPM around the nadir axis

- The result is a 1000-km swath on the ground

- The radiometer data is more accurate than the SAR data, but has a spatial resolution of about 40-km; the SAR spatial resolution is 1 – 3 km
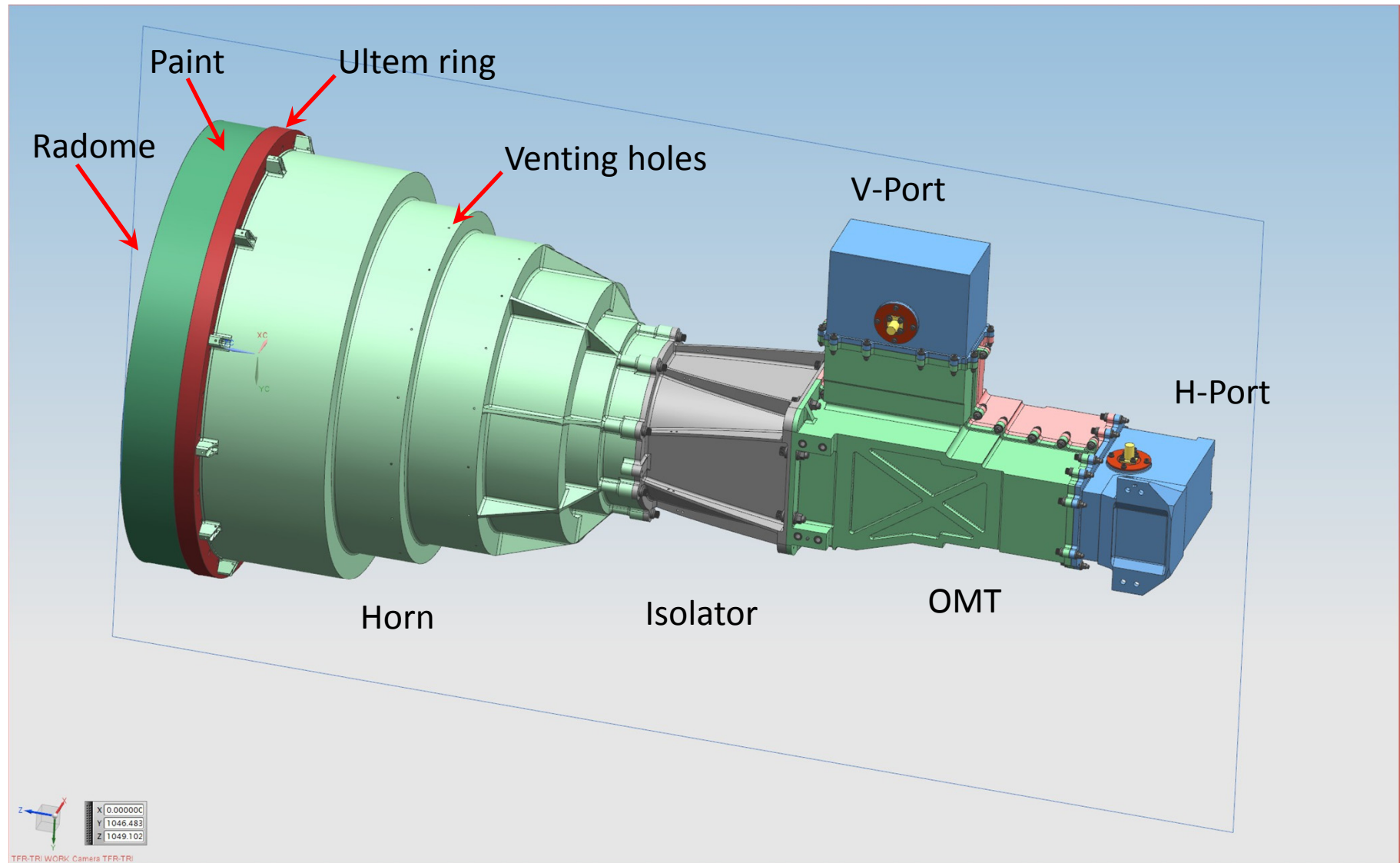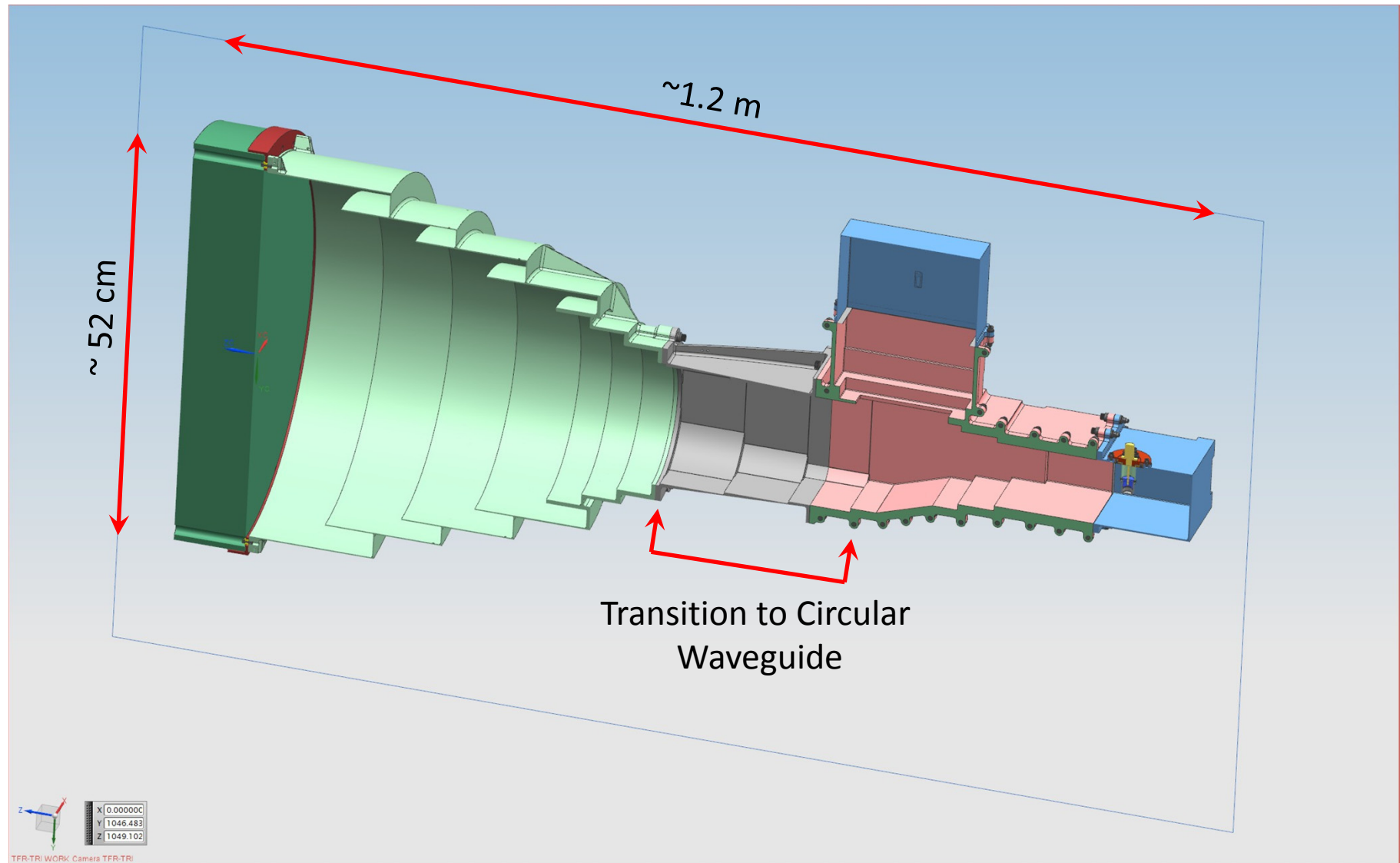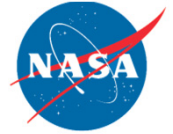

Antenna Beam Footprint

1000 km

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SMAP "E" Configuration

35.5°

6m

Isometric View

Cut-away Isometric View

Transition to Circular Waveguide

~1.2 m

~ 52 cm

Waveguide to Coax Adapter (WCA) Detail

TNC Connector
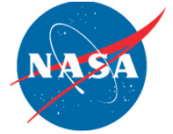
Base plate

Ultem sleeve
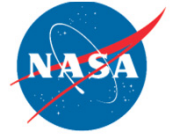
Tuning Iris

Emitter
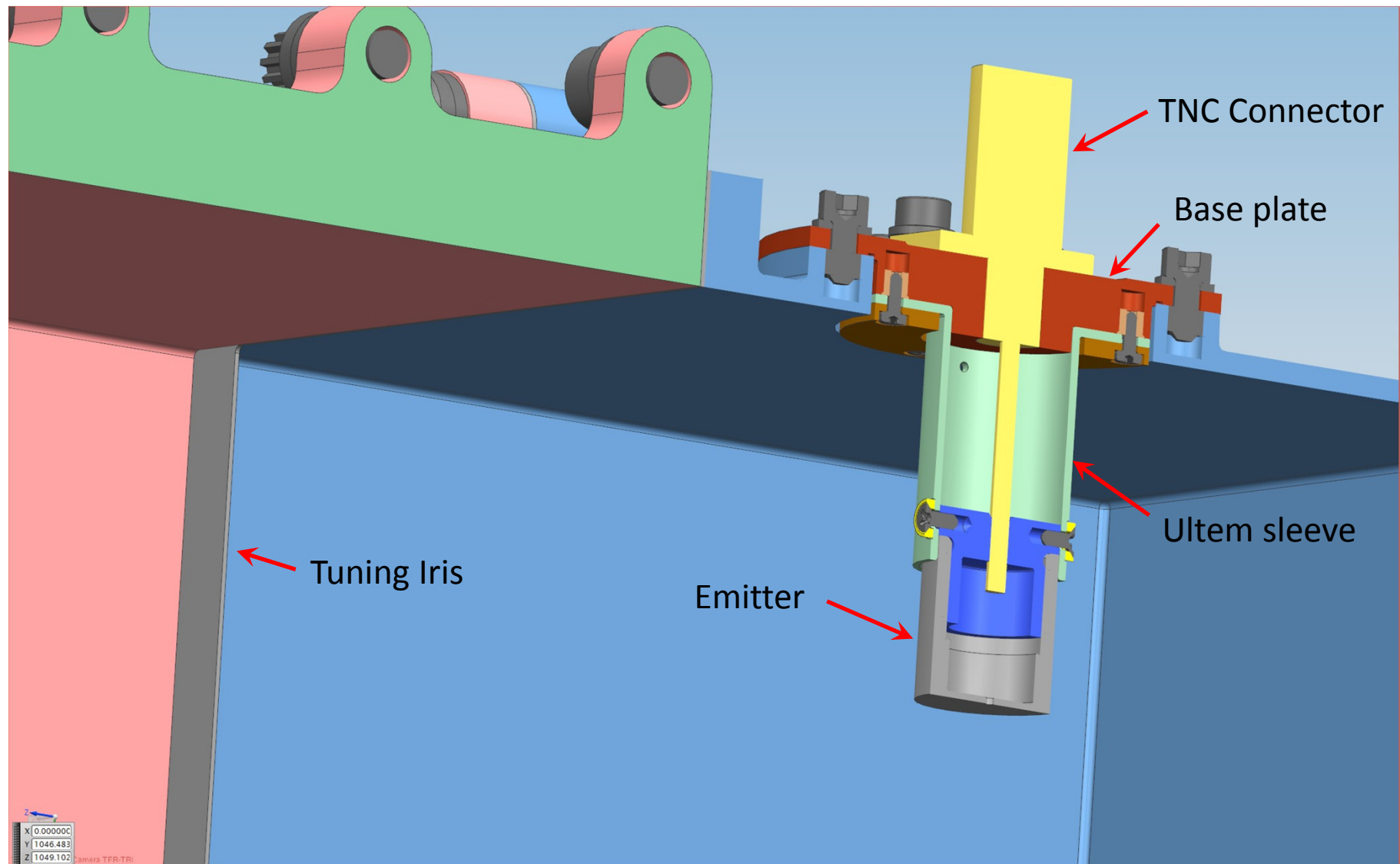
WCA Prototype Measurement
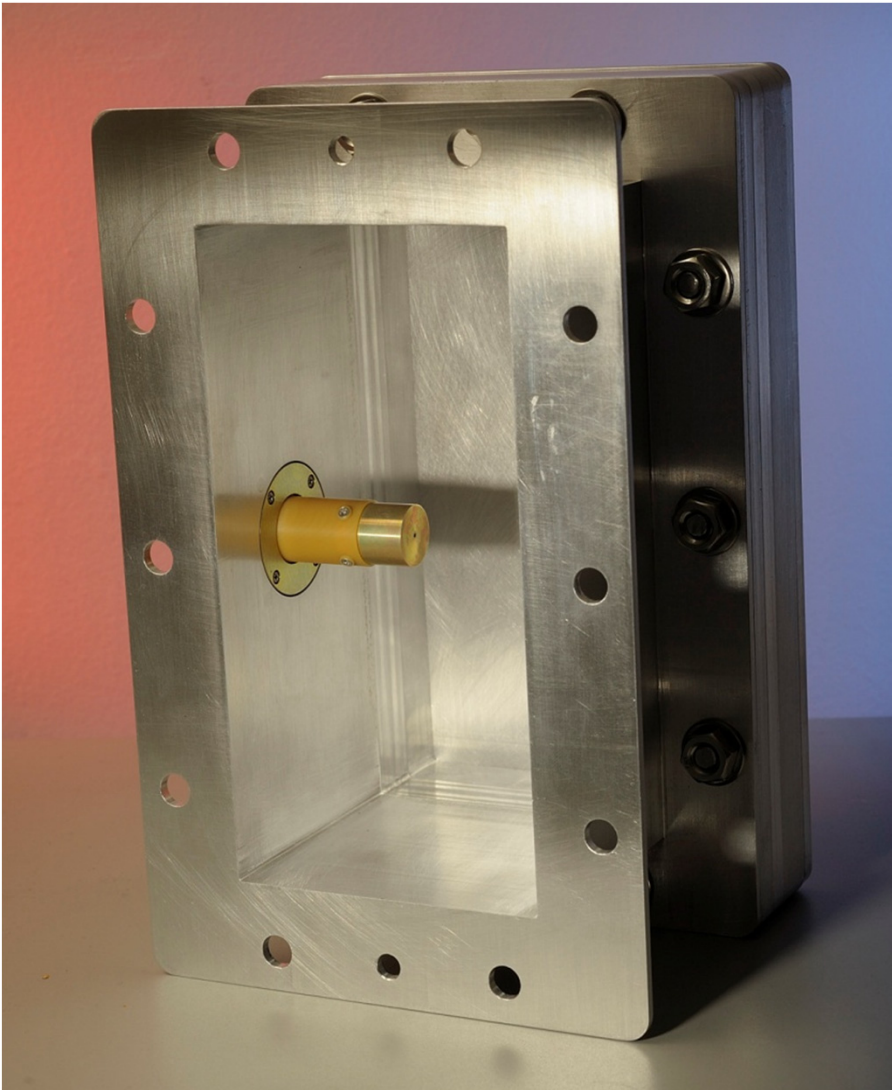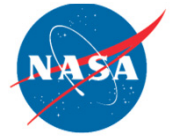

WCA Prototype being tested with WR650 Cal Kit
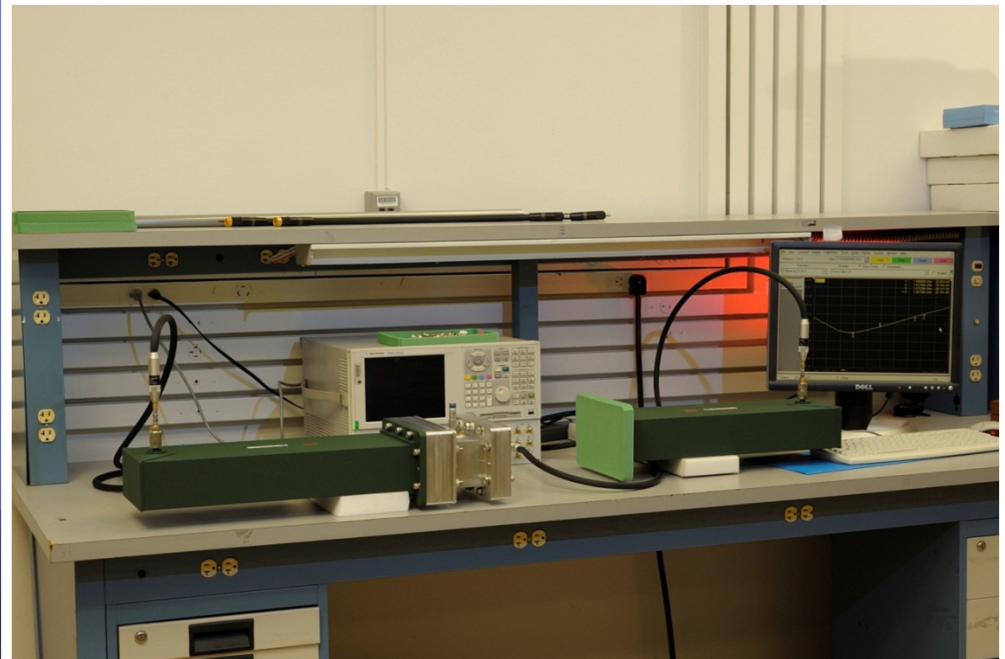
Major Design Drivers & Requirements

- Combined SAR & RAD RF bandwidth of 16%
- Radiometer beamwidth & main beam efficiency
  - RAD Beamwidth between 2.29° and 2.5°
  - RAD MBE > 87%
  - SAR Beamwidth < 2.8°
- Radiometer antenna pattern stability
  - RAD Earth Lobe power < 3%
  - RAD off-Earth Lobe power < 10%
- SAR gain and gain stability
  - SAR Gain > 35.55 dBi
  - SAR Gain stability < 0.07 dB
- SAR pointing stability
  - 50 m° ± 40 m° in Elevation
  - 0 m° ± 10 m° in Azimuth

Thermal & Alignment Tolerances

Pin and slot locations

Pin and slot locations
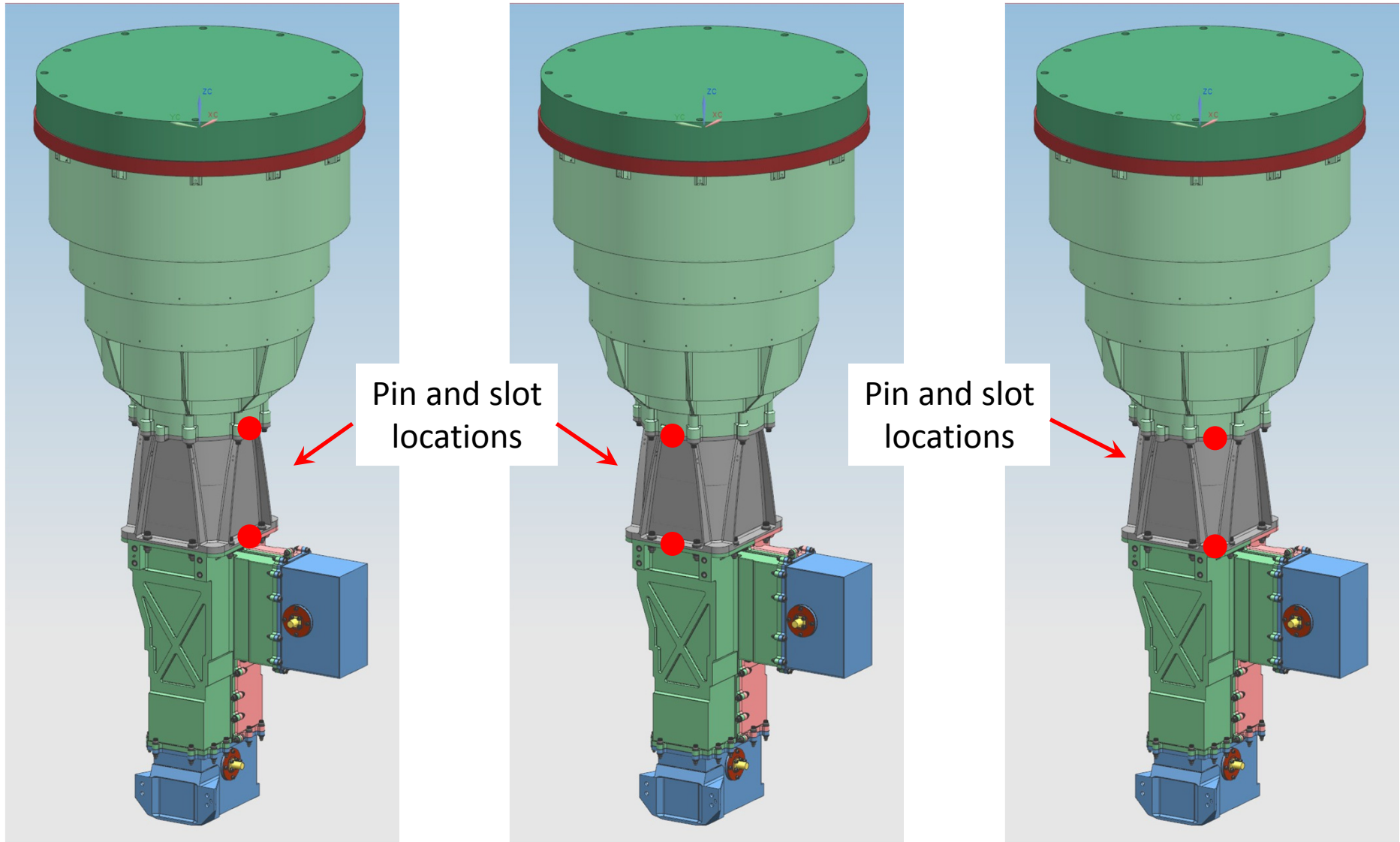
Worst Case Thermal + Alignment Tolerances
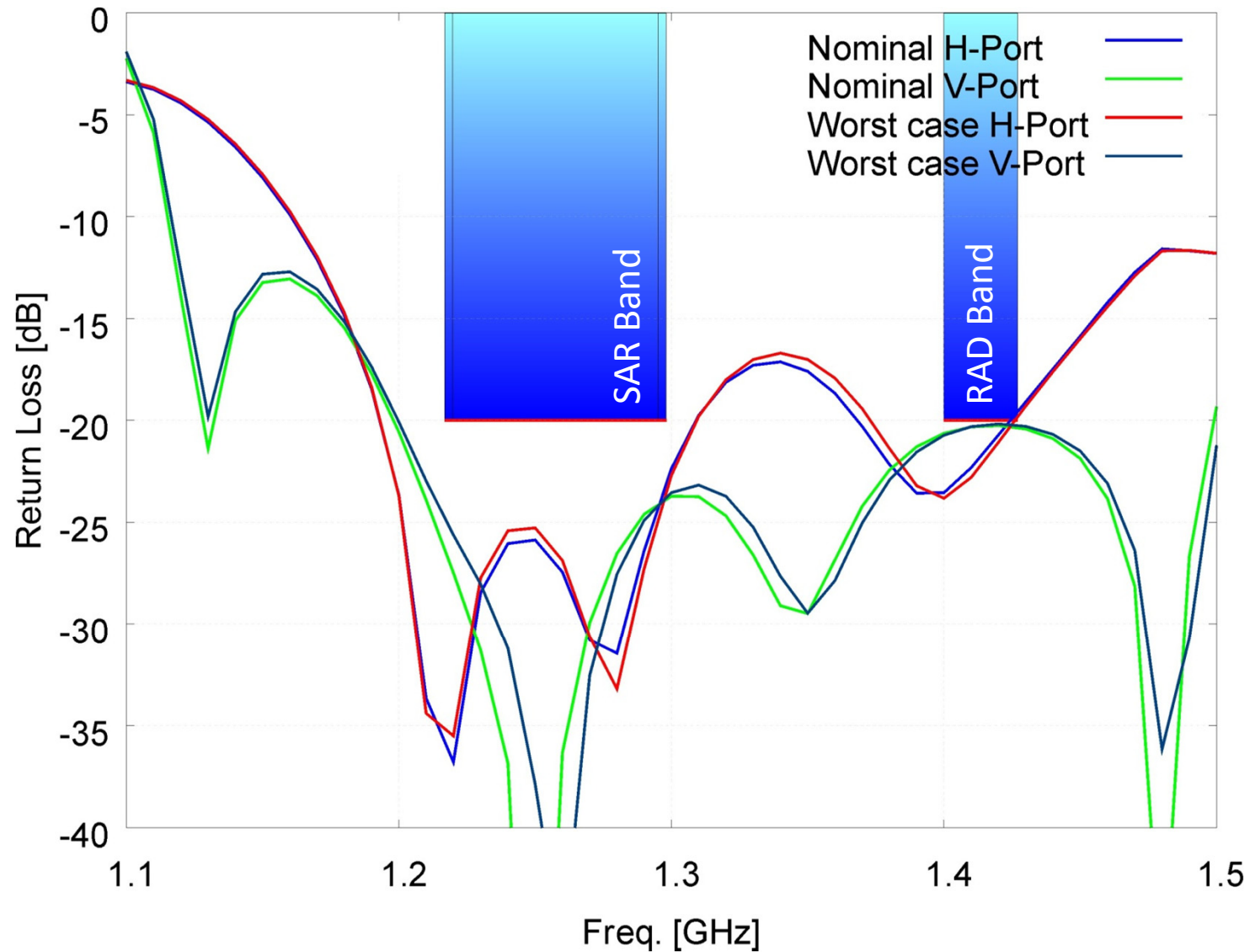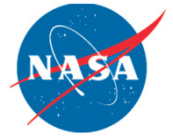
Split OMT Tolerance Performance
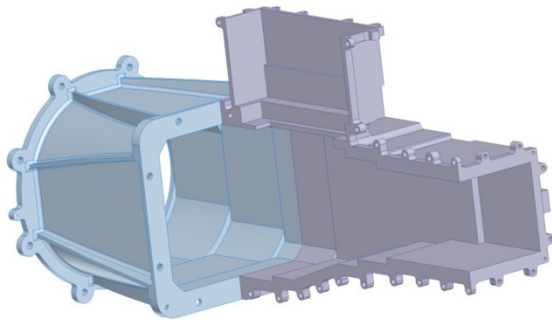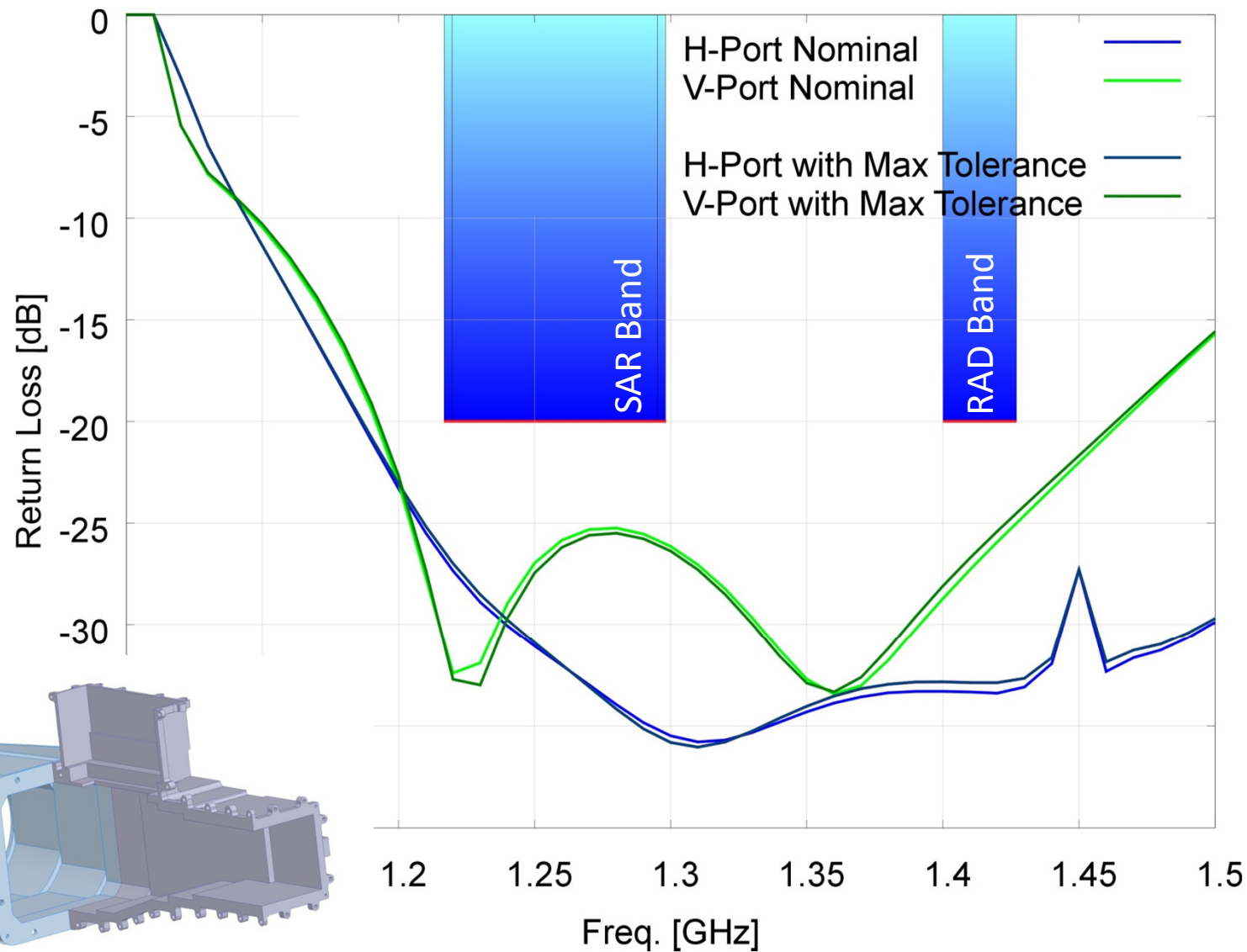
SMAP Flight Model
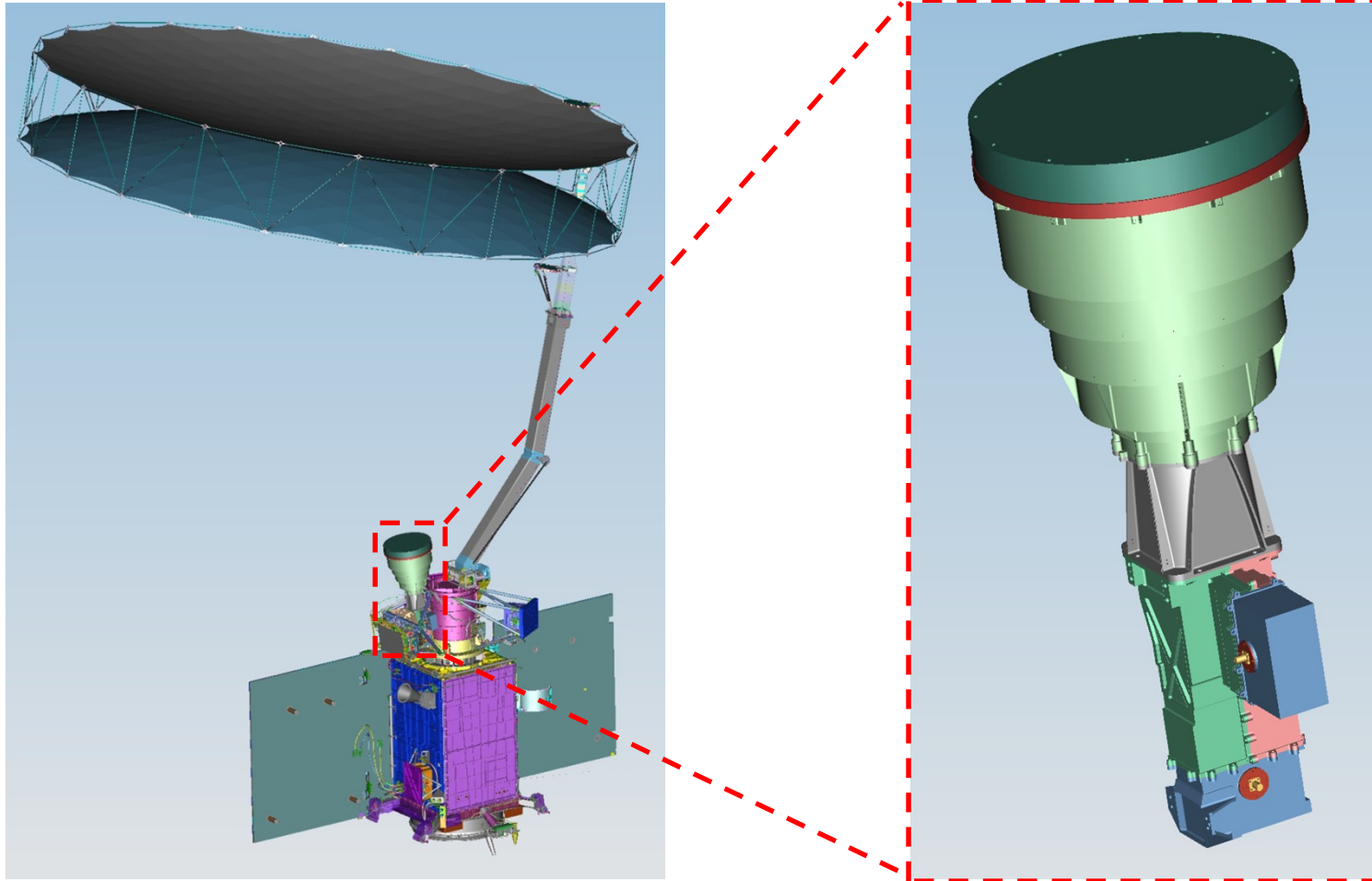
SMAP Scale Model
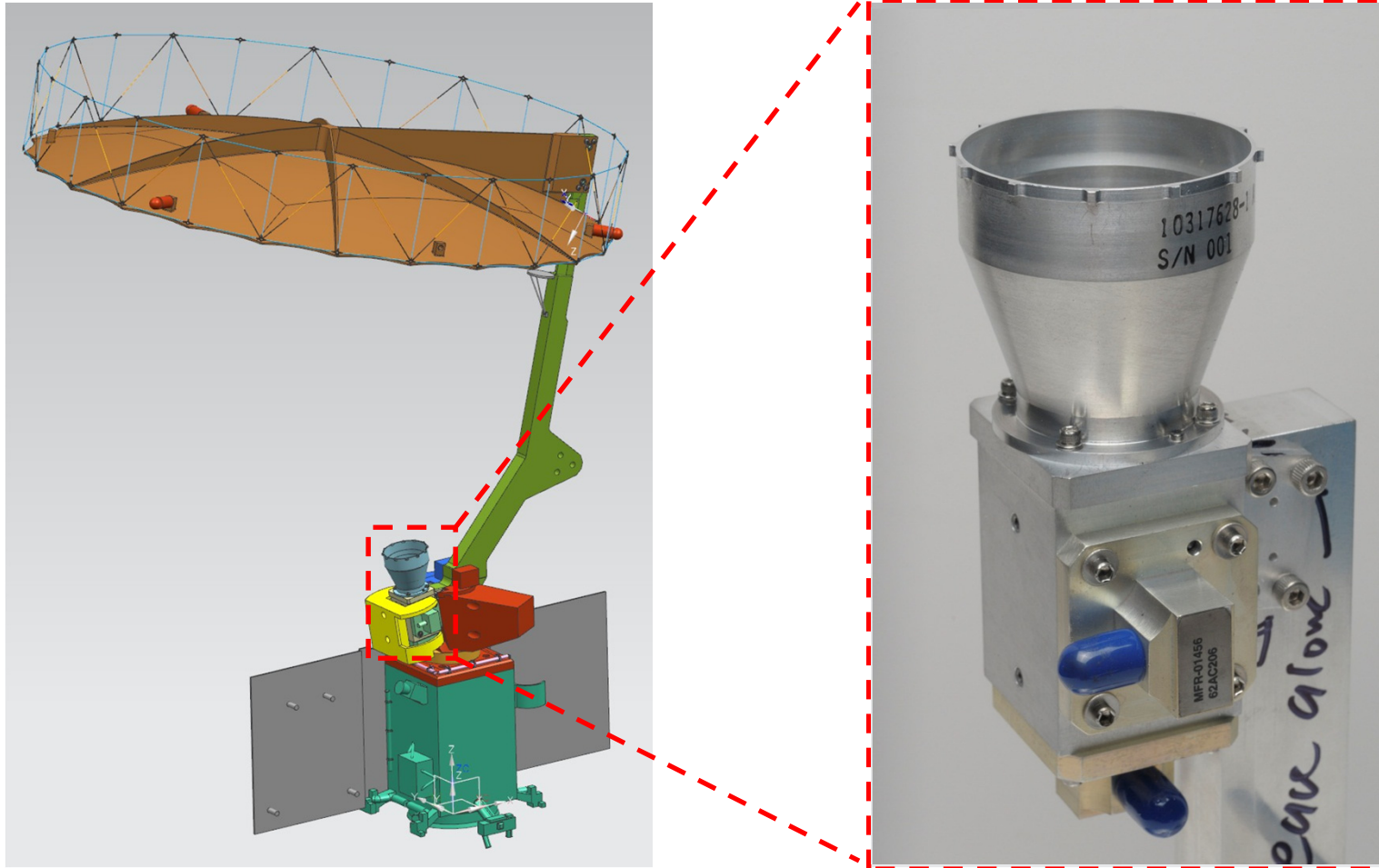
SMAP Complete Scale Model

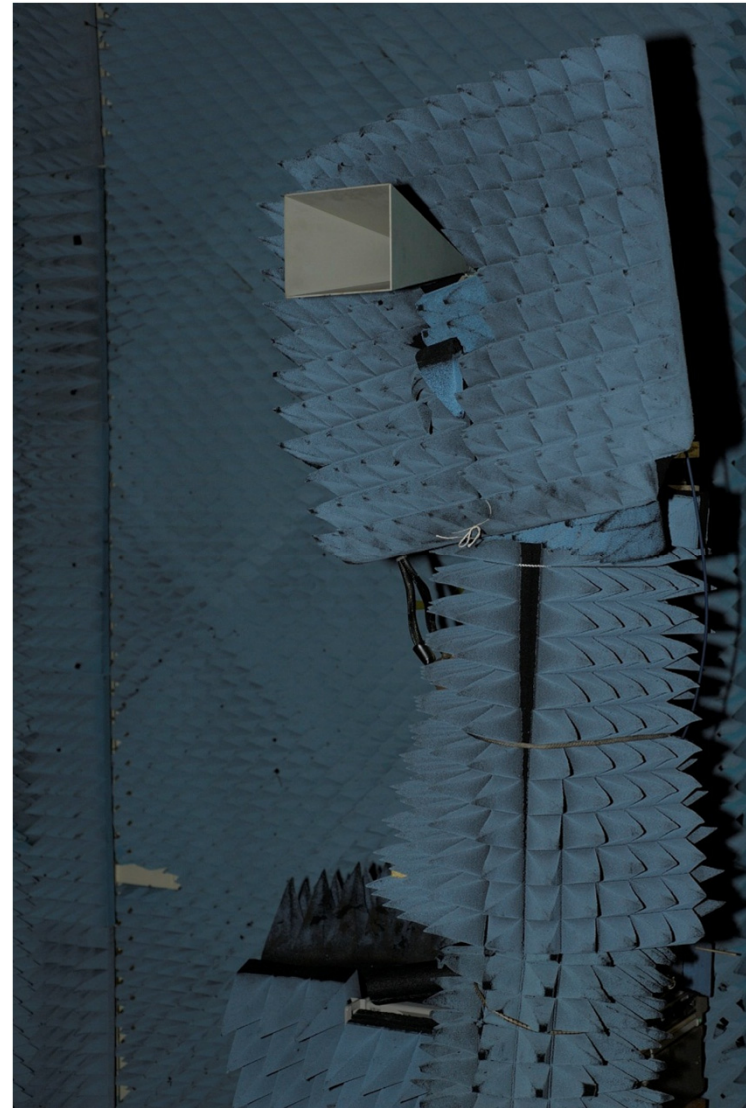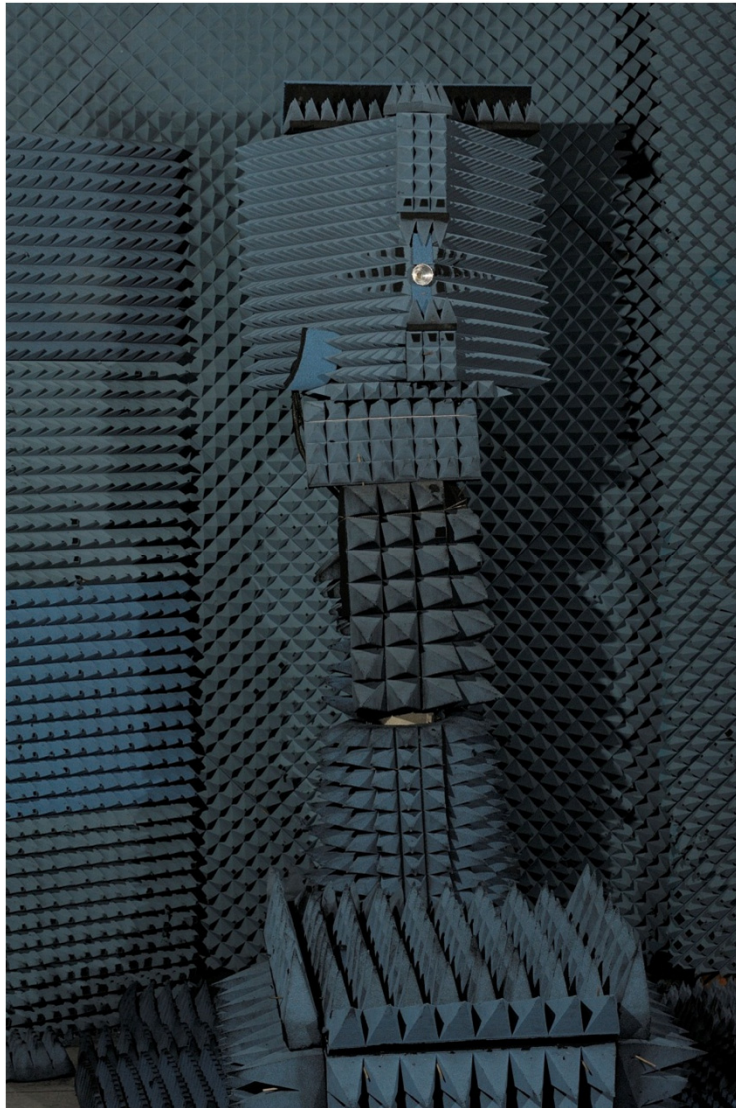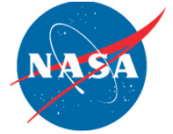# Scale Model Feed
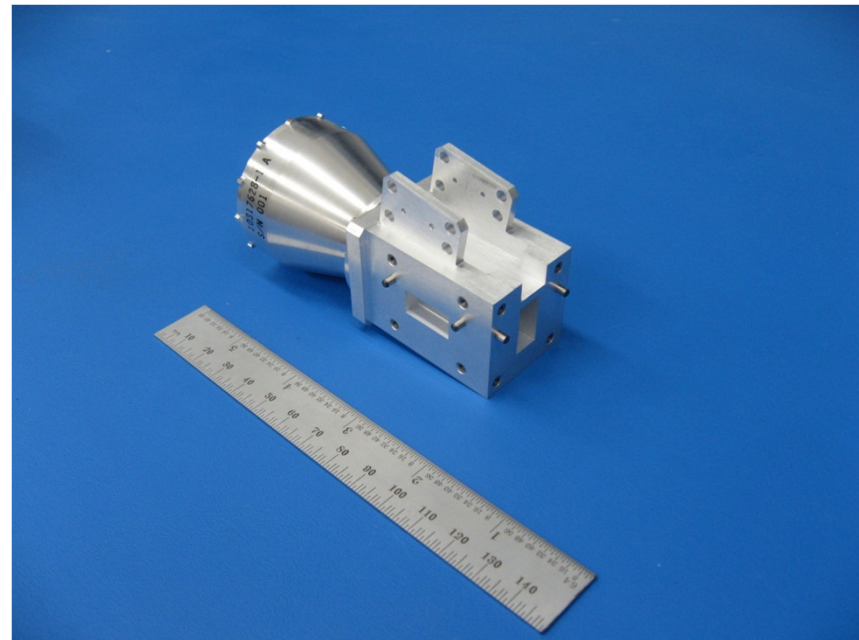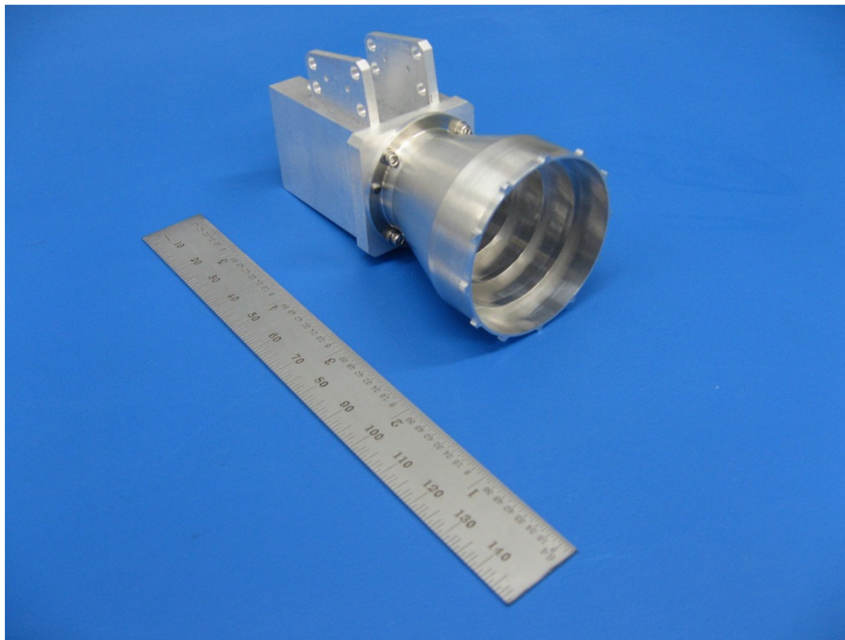
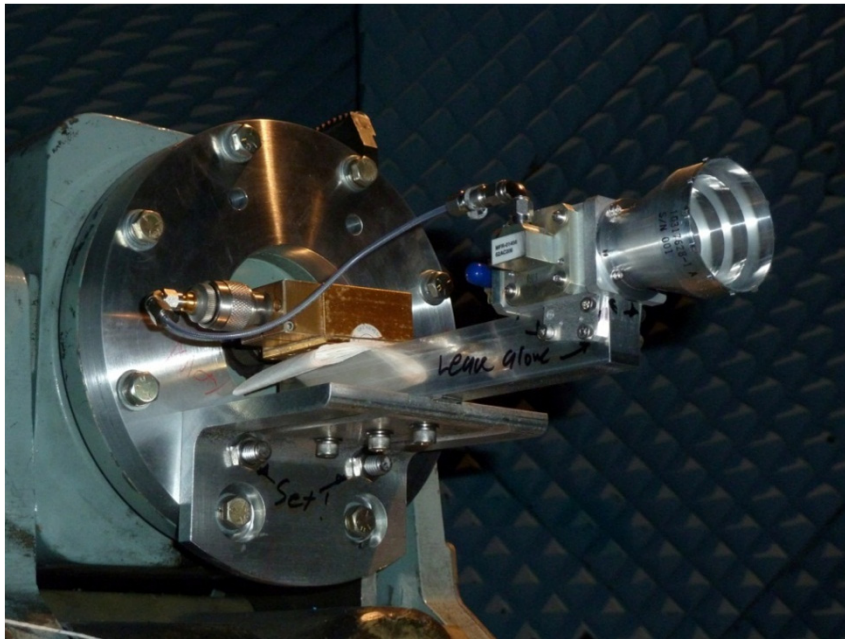# Return Loss Measurements
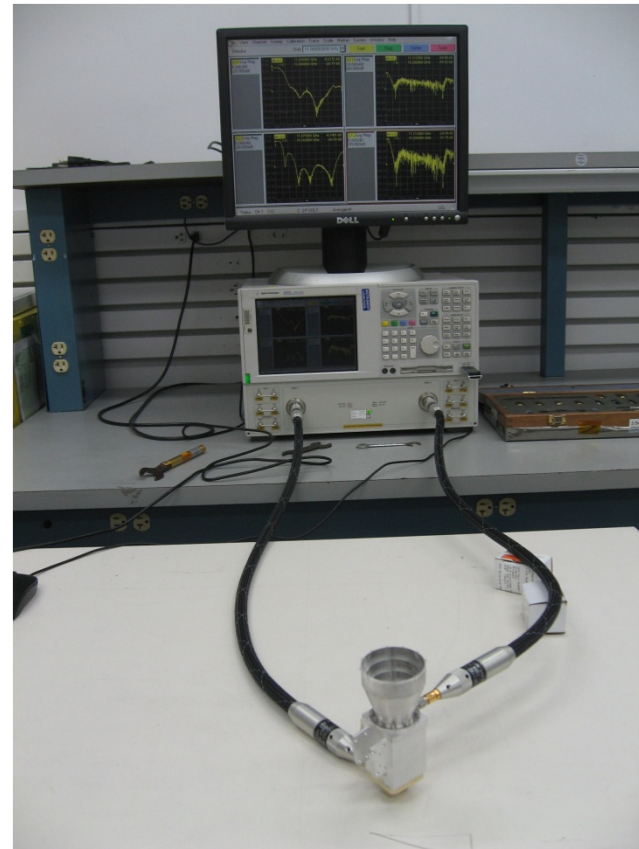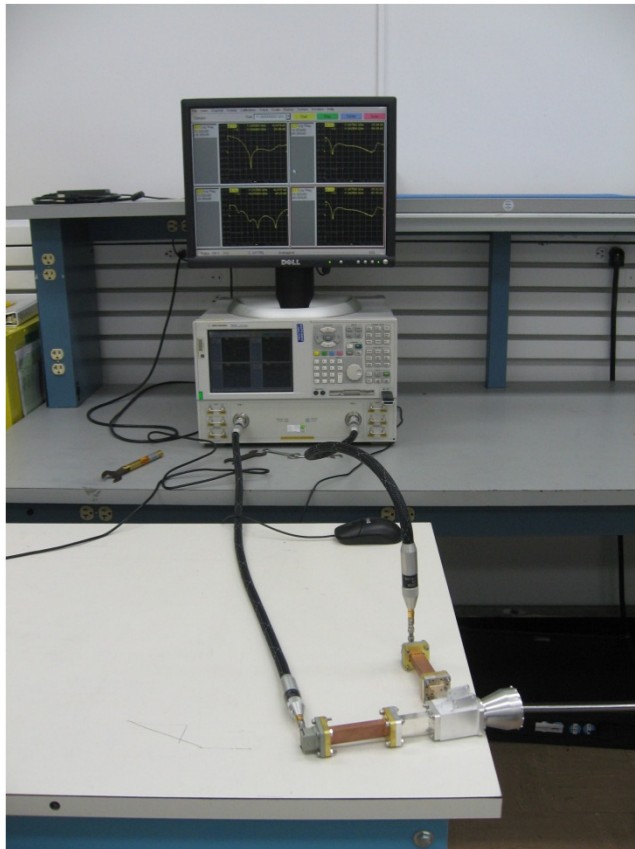
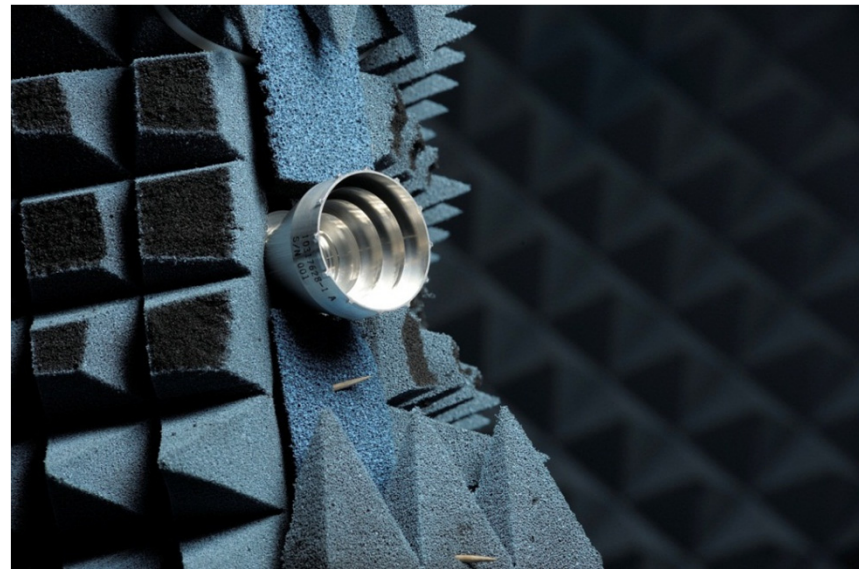# Radiation Pattern Measurement
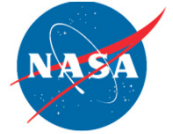

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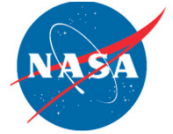
Close-up of the Scale Model Feed Horn

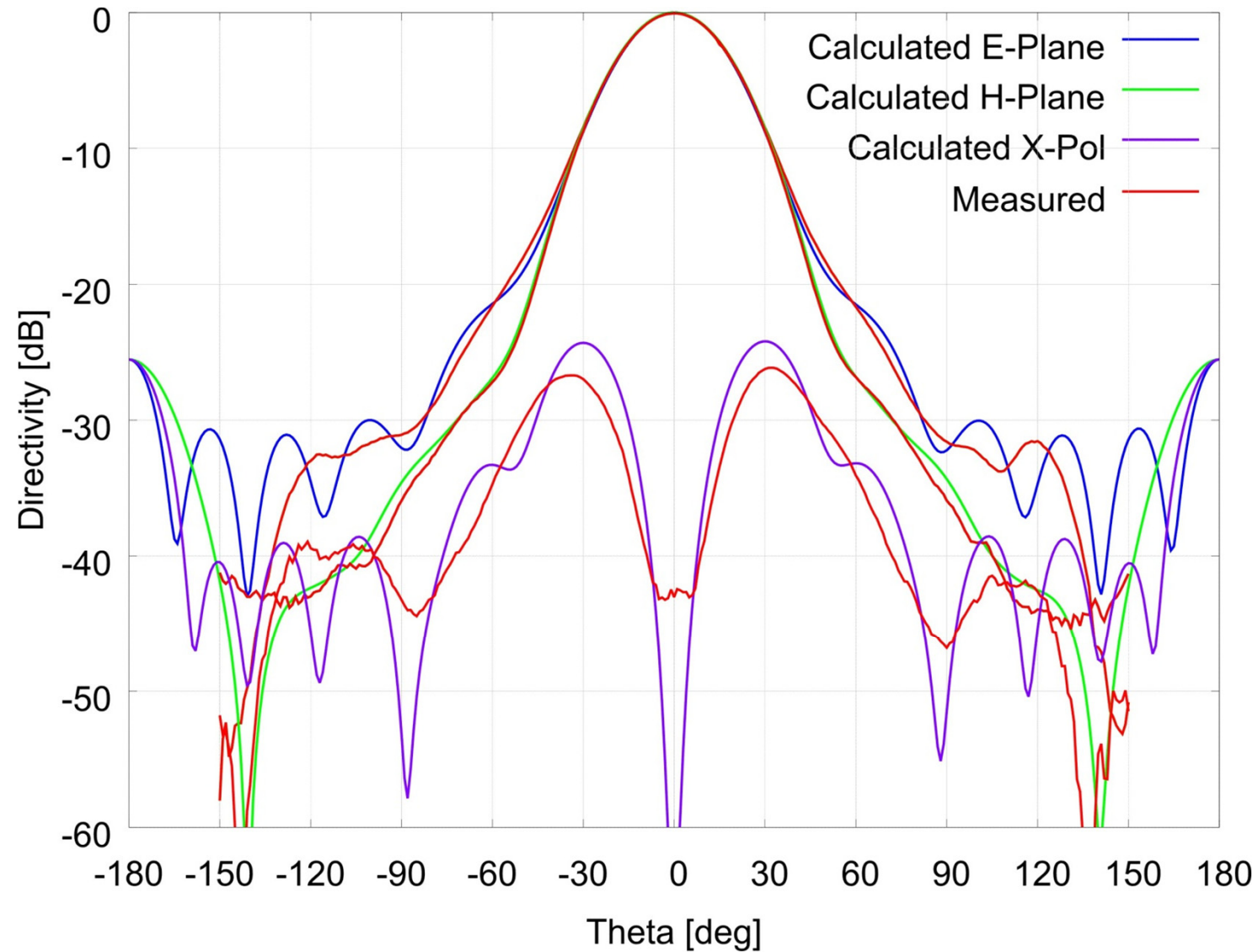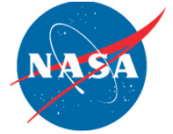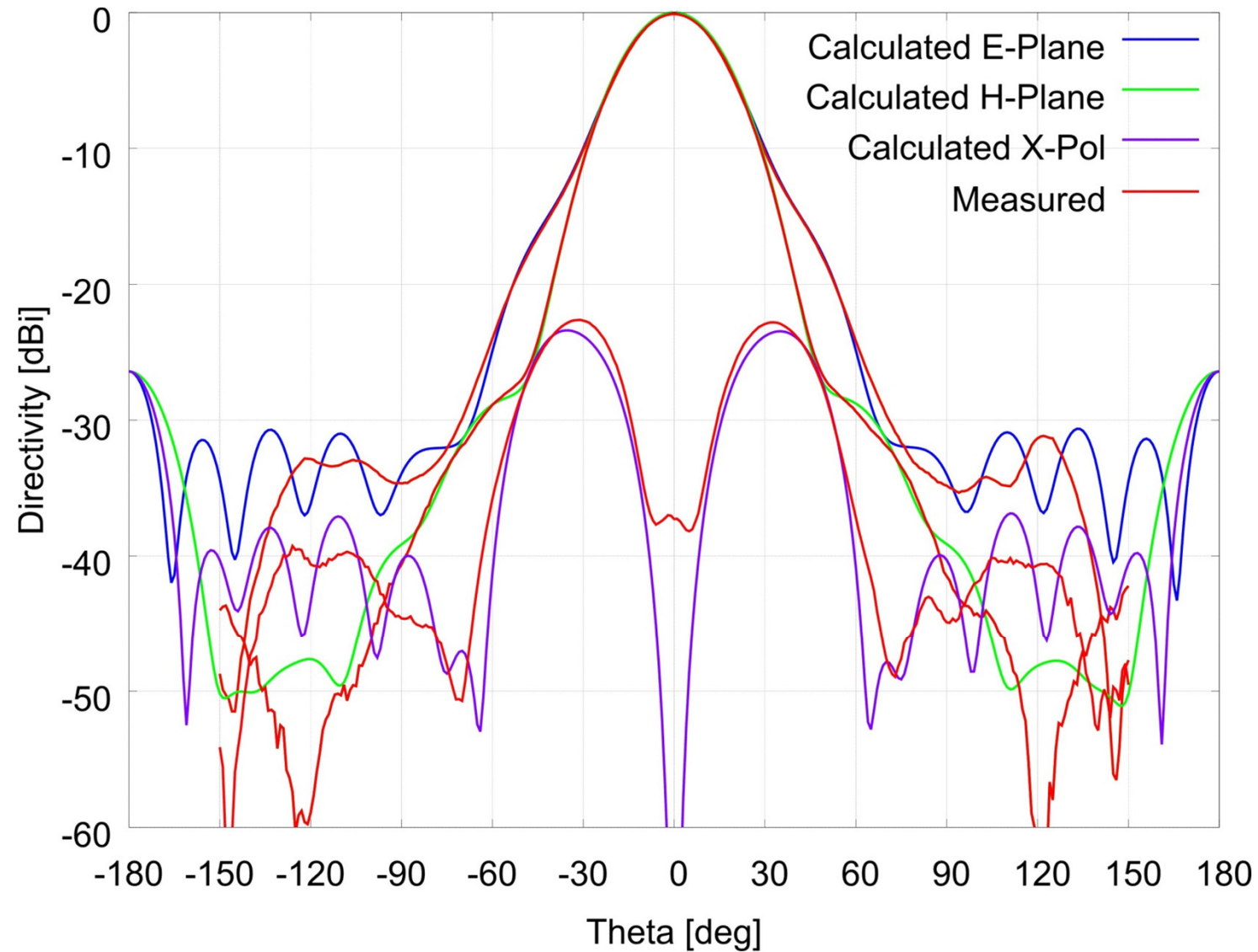**Scale Model Feed Horn on Antenna Range Positioner**
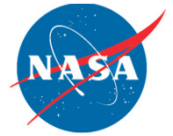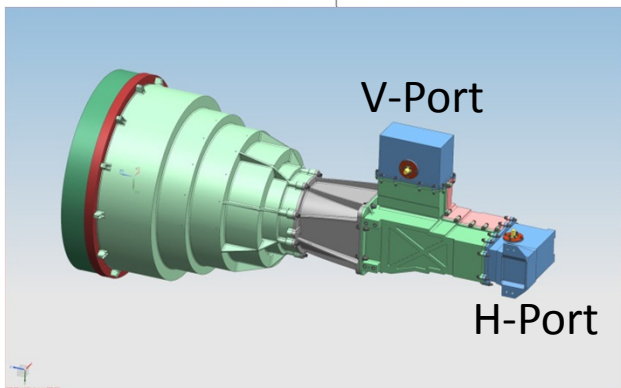
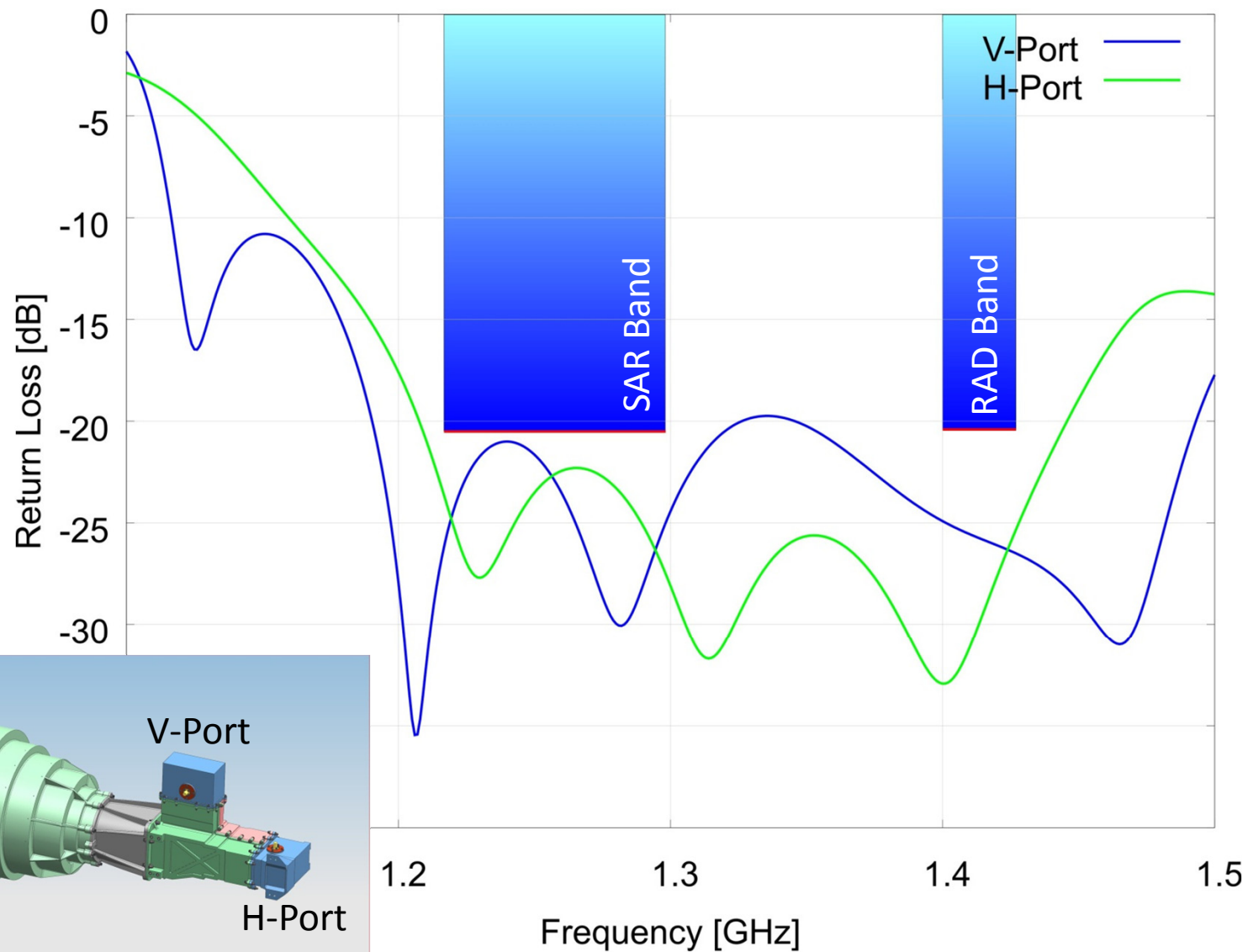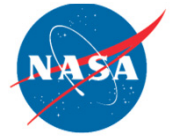**Scale Model Feed Horn with Absorber in Place**
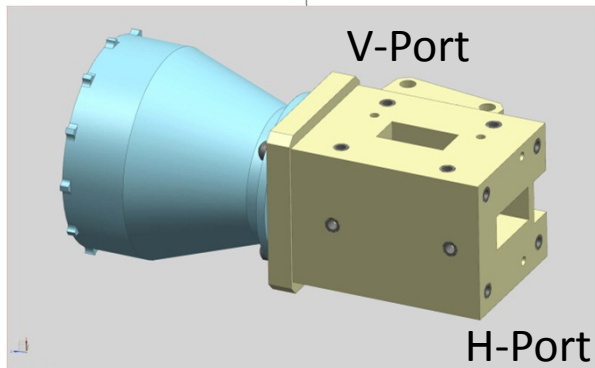
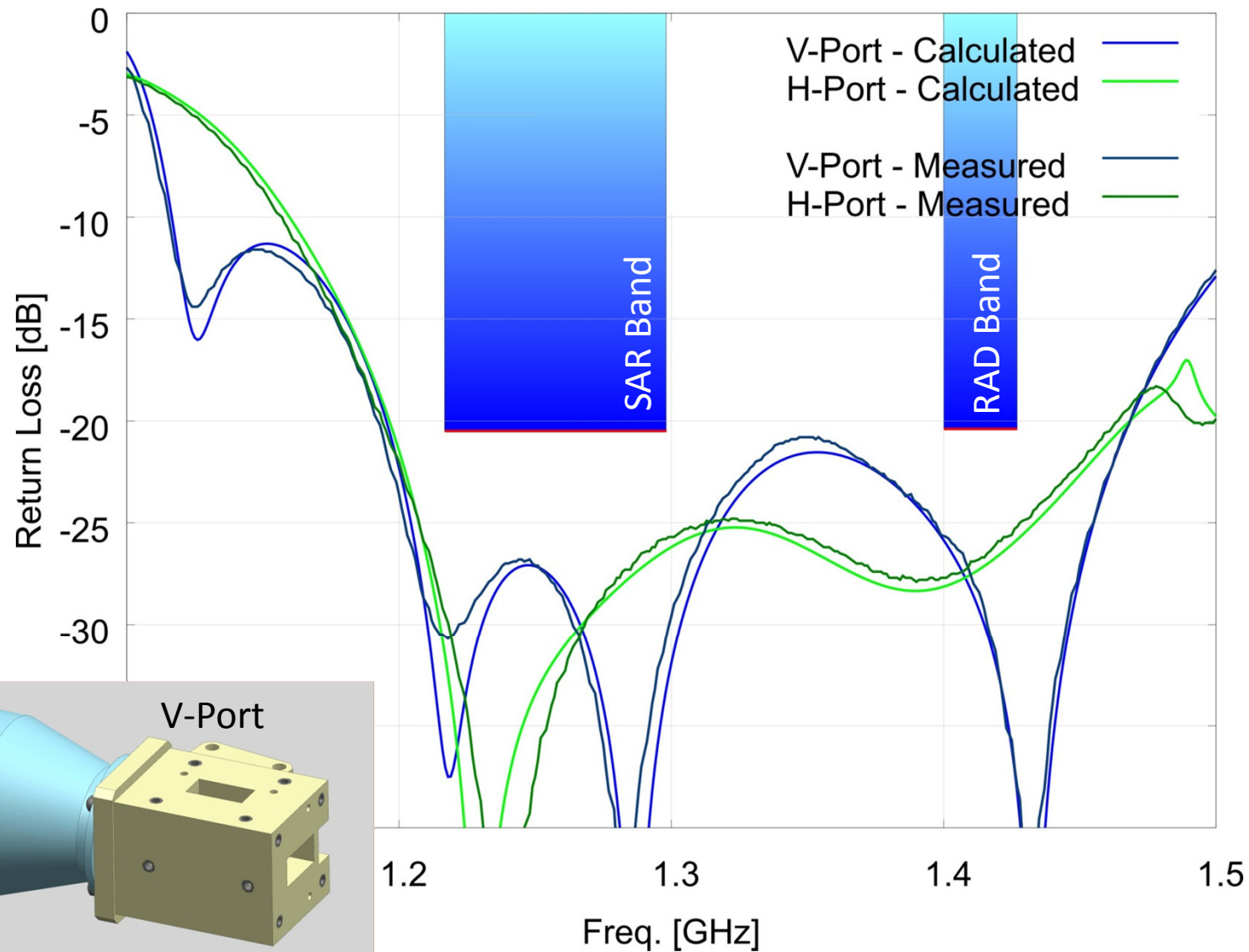# SAR V-pol Scale Model Pattern

RAD V-pol Scale Model Pattern

Flight Feed Horn RL
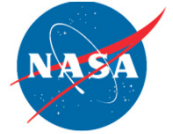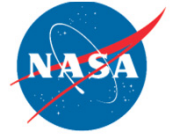
Feed Horn RL into SM OMT

Conclusions

- A dual-polarized, dual-frequency, corrugated feed horn for SMAP was designed and meets all mission requirements

- A scaled model of the feed was fabricated and tested showing an excellent agreement with predicted performance

- These results along with the "tunability" built-in into the flight model make us feel confident that the flight model will meet all mission requirements
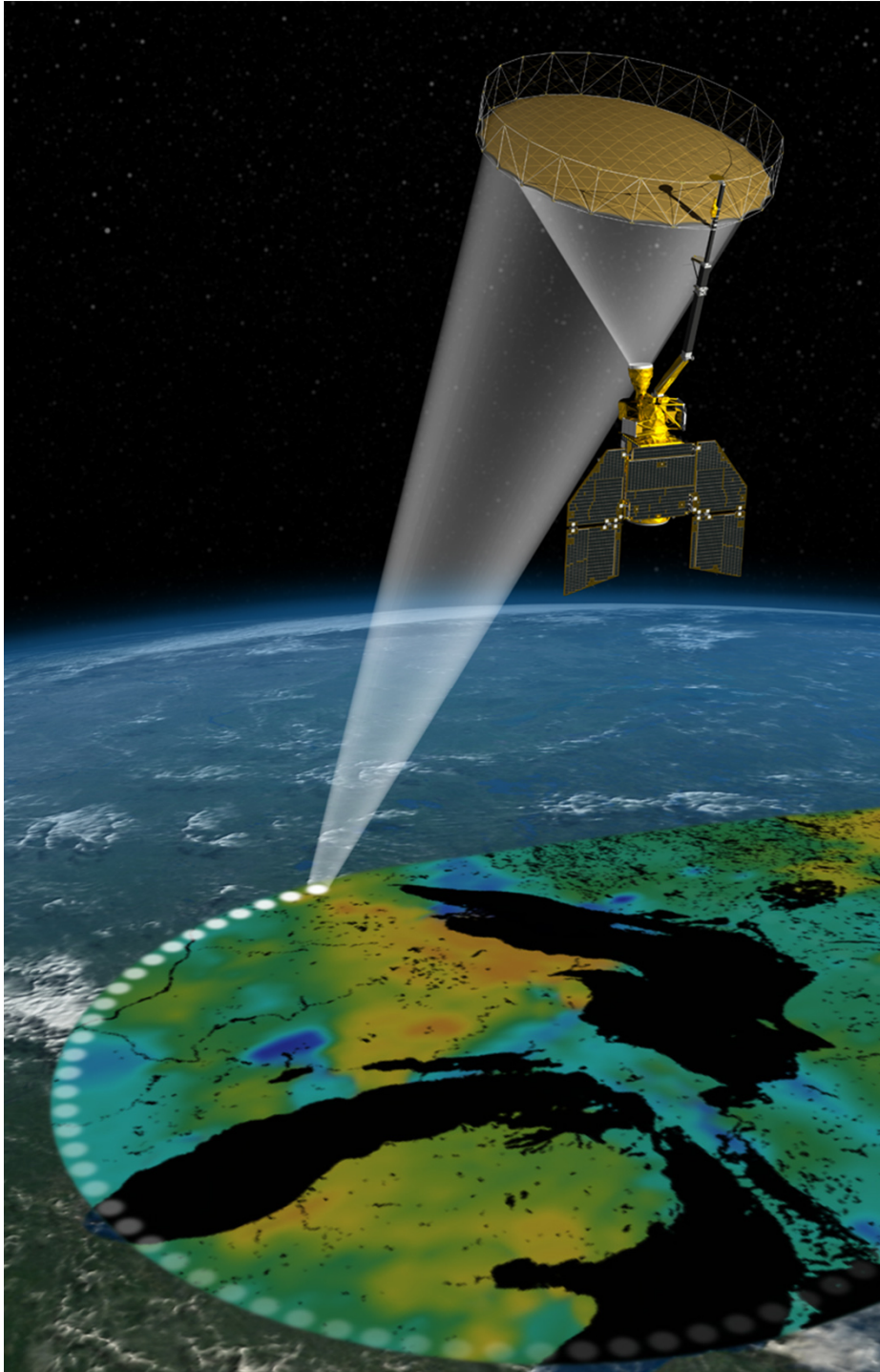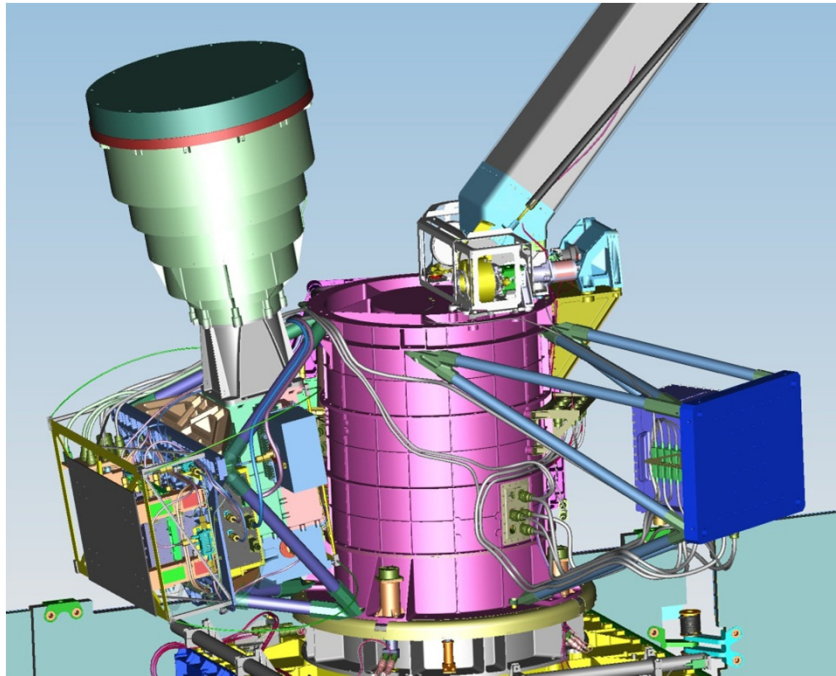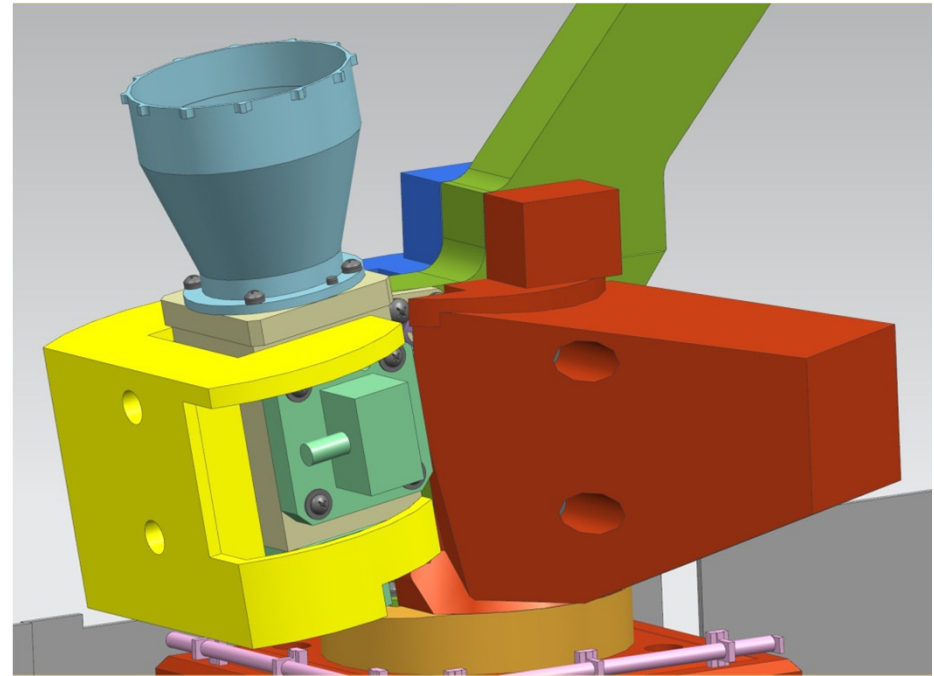
Thank you!
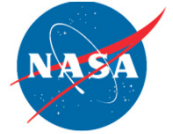
Back-Up

SMAP Instrument
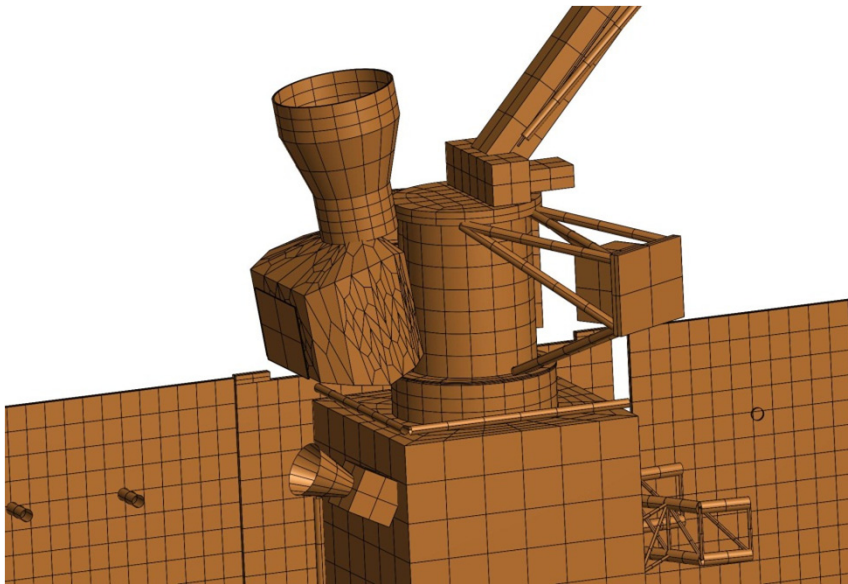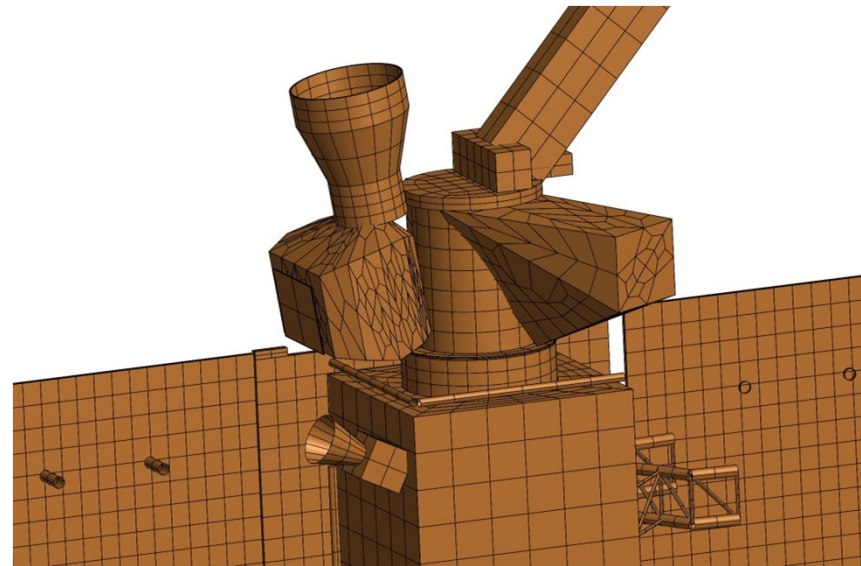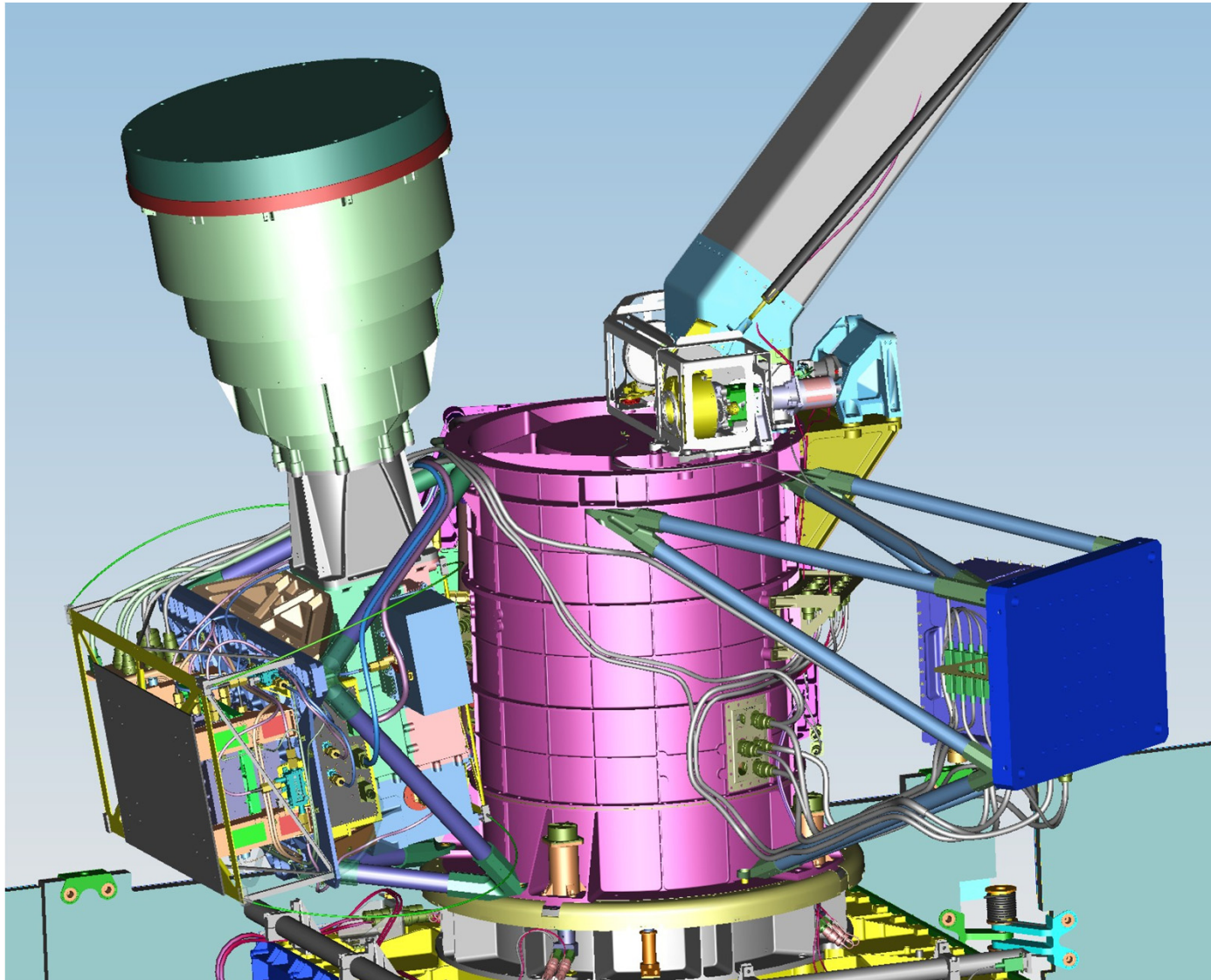
Flight Model

Scale Model
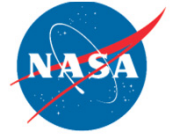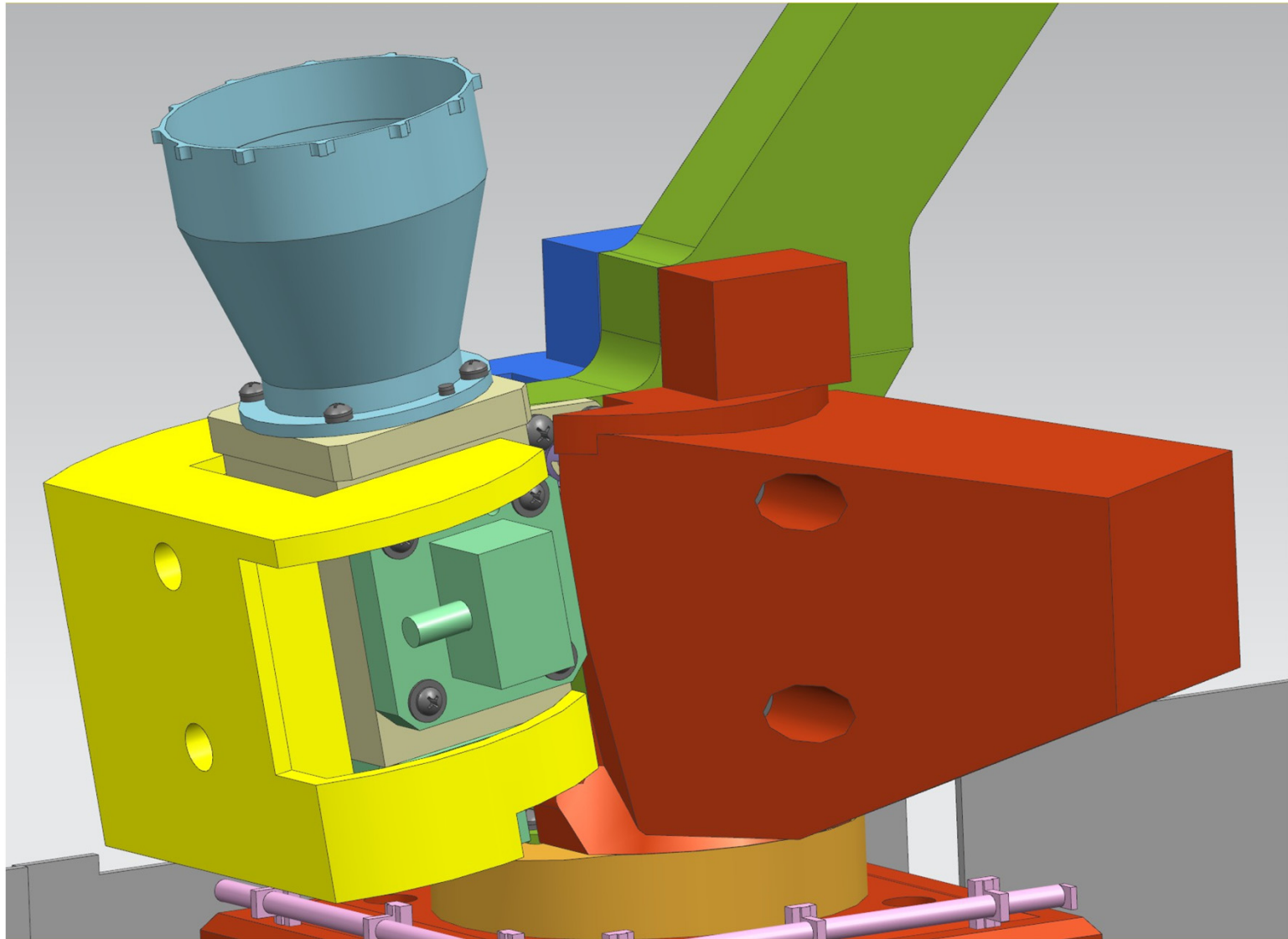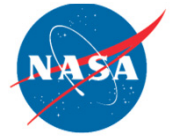
RF Models

Flight RF Model

Scale Model RF Model

SMAP Flight Instrument

SMAP Scale Model Instrument

Radome